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Examining connections between the physical and the mental in education: A linguistic analysis of PE teaching and learning

Tammy Slater
Iowa State University, tslater@iastate.edu

Joy I. Butler
University of British Columbia

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Keywords
Systemic functional linguistics, Knowledge structure, Academic literacy development, science, physical education, teaching

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Abstract

Discourse analyses of science teaching have revealed patterns of knowledge structures (KS) reflecting Halliday's observation that science teaching involves constructing technical taxonomies and relating them in logical sequences. In science education, this pattern has included problem solving as a way for teachers to assess learning. Science has always been considered an academic subject, but how does it compare to physical education (PE)? Given that language is the primary means through which we learn and assess learning, we present a discourse analysis of a sixth-grade PE class taught using a Teaching Games for Understanding (TGfU) approach and compare the discourse to analyses on science teaching. Findings suggest that in the discourse of both PE and science classes, the six KS identified by Mohan as comprising a framework for activities (KF) appear in similar patterns. This focus on similarities rather than differences across diverse disciplinary fields has major implications for educators.

Key Words

Systemic Functional Linguistics; knowledge structures; academic literacy development; science; physical education; teaching

1. Introduction

The development of English literacy alongside content is undoubtedly one of the most important goals of any English-medium education worldwide and is especially noted in the recent adoption by several US states of the Common Core Standards (Common Core State Standards Initiative, 2014). The teaching of literacy involves the development of academic language and thinking skills—academically appropriate ways of thinking, talking, and problem solving within disciplinary areas. Dialogue in classrooms has much to do with this development, as discourse plays a central and critically important role at all levels of education (Wells, 1999), and "students who engage in frequent and productive oral discussion of academic subject matter are likely to be better prepared for written academic discussion" (Leung & Mohan, 2004, p. 356).

Much has been written on the language development that occurs in content areas such as science (e.g., Fang & Schleppegrell, 2008; Huang & Morgan, 2003: Lemke, 1990; Martin, 2013; Mohan & Slater, 2005; 2006; Schleppegrell, 2002), history (e.g., Coffin, 2006; Fang & Schleppegrell, 2008; Martin, 2002; 2013), and mathematics (e.g., Barwell, 2005; Huang & Normandia, 2008; Leung, 2005; Street, 2005; Veel, 1999). Yet little has addressed how sports education connects with literacy education; in fact many physical education teachers consider literacy development to be outside their realm of expertise, given their focus on movement and activity (Behrman, 2004; McGuire, Parker, & Cooper, 2002). Are there linguistic connections between the physical nature of athletics and the mental nature of academics that can be exploited for the development of academic literacy in PE classes? In this paper we argue that because language is the primary medium through which education is carried out and assessed in all content areas (Halliday, 1999, 2007; Wells, 1999), a theoretically grounded linguistic comparison of the discourse of teaching physical education (PE) and the discourse of teaching science, which is typically considered a much more "mental" content area (a "highly valued domain," as Halliday 2007, p. 305, stated), should reveal similarities and differences that can inform researchers and educators in both PE and literacy fields.

2. Framing the study

To begin our examination, we will consider the teaching and learning of PE in the schools from James Spradley's notion of a social practice, a unit that involves cultural *knowledge* and cultural *action* in a theory–practice, or reflection–action relation (Spradley, 1980). There are examples of social practices everywhere. Learning to create stained glass art and actually creating stained glass art are both social practices. Teaching and learning about sports games and playing those games are also social practices. Each social practice can be identified by its register:

> Registers are ways of saying different things: using language in different contexts, for different purposes… English in the maths class is not the same as English in the history class, let alone English in the drama class or in the playground. Children in the middle school age group are beginning to build up a register range. (Halliday, 2007, p. 52)

Within a social practice, there are knowledge structures (KSs), which are semantic patterns of the discourse, knowledge, actions, artifacts, and environment of the social practice. Whereas Halliday's words strike at the differences that define registers, in *Language and Content,* Mohan (1986) proposed that a small set of KSs can be related to both language and content and thus they can underlie subject area knowledge and thinking. Following Mohan, the KSs in our linguistic model of a social practice are of two levels of discourse: the knowledge or theory level, which includes the KSs of classification, principles, and evaluation, and the action or practice level, which includes the corresponding KSs of description, sequence, and choice (see Figure 1).

Mohan's work on the connections between social practice and register (Mohan, 2011) addressed the differences between the two levels of theory and practice, suggesting that action discourse is used to *enact* the social practice, while reflection discourse is talk *about* the social practice. Mohan illustrated this difference by suggesting how the reflection discourse of teaching a card game is very different from the discourse of actually playing the game. This idea is especially relevant for our discussion of the language of teaching and learning PE, which can be very different from the language used when students play sports, just as the language of teaching and learning science can differ from the language of doing experiments. By examining the language of a PE unit, we can make judgments about the functions of language—and thus the thinking skills that this language is constructing—that teachers are engaging students in to construct their knowledge of sports. We can then compare such language to the teaching and learning of science.

3. The theoretical framework

Reflecting the epistemological orientation of systemic functional linguistics (SFL), the argument and analysis presented in this paper uses excerpts of language in context and aims to explain these texts in part by identifying their forms as functional meanings. To do this, we adopt the knowledge framework (KF), fully described in the seminal work on the integration of language and content in Mohan (1986). The KF is a tool, a heuristic that provides a starting point for identifying student tasks and questions that can help integrate the development of academic language with the content knowledge. It reflects the categories of thinking skills identified in curriculum documents, resource guides, and textbooks across a variety of subject areas in Western Canada (see Early, Thew, & Wakefield, 1986). These thinking skills recurred in the curriculum objectives and manifested themselves in the way language was used throughout these documents.

The KF is comprised of six boxes representing three related pairs of knowledge structures, or KSs, as shown in Figure 1.

CLASSIFICATION	PRINCIPLES	EVALUATION
DESCRIPTION	SEQUENCE	CHOICE

Figure 1

Mohan's Knowledge Framework (Mohan, 1986)

These three pairs form theory/practice relationships that can be illustrated simply in the following ways:

(1) Classification/Description: Describing something infers an understanding (theory) of a set of classifications such as color, size, or other typologies/taxonomies. Teaching new classifications of "things" or "actions" involve ensuring that students understand and can label these things or actions in some way that is valued in the discipline they are studying.

(2) Principles/Sequence: Sequencing actions or ideas is typically informed by knowledge (theory) of causes and effects or means and ends in that we order things or actions in logical ways because we are aware of what we are attempting to achieve (means/ends) or what may happen if the things or actions are in an inappropriate order (cause/effect). Teaching typically involves ensuring that students understand the connections between what they might see or do, and how that relates to established rules and theories within the disciplines.

(3) Evaluation/Choice: Making a choice (practice) involves being able to evaluate those choices in some way, or having values (theories) concerning the available options. Problem solving and decision-making cannot typically be done without some understanding of the theory behind the available choices. Teachers use problem solving and decision-making as forms of assessment (which we see as evaluating student choices) to establish whether learning is occurring.

Each of the KSs has both language features and thinking skills associated with it, and each has specific key visuals that relate to the language and thinking skills. For example, classification involves grouping, talking about part/whole relationships, and defining. A classification tree can capture the first two of these, with an equals sign suggesting the third. The language associated with this KS includes verbs such as "be," both as a relating process and in talking about existence, as in “there are.” The verb “have” is also a salient feature of the KS of classification. Within classification, the things that are talked about are typically general rather than specific (games and positions rather than “this game we are playing right now”), and words and phrases such as “types,” “kinds,” “include,” and “made up of” are typical parts of the lexis. For teachers of English language learners in the schools, Mohan and his followers (e.g., Early, 1989; 1990; 1991; 2001; Early & Tang, 1991; Tang, 1991, 1992, 1997) used these understandings as ways to help students grapple with the demands of academic language across curricular areas. For researchers interested in using KS analysis to explore classroom discourse, there are relatively few areas that have been addressed. The following represent those areas.

Since Mohan (1986), KS analysis has been used to illuminate the types of meanings that are constructed in a variety of contexts, addressing issues of importance within teaching and testing. For example, KS analysis has been used to describe potential approaches to project-based language teaching (see Slater, Beckett, & Aufderhaar, 2005), to bring out differences in how information is presented by nonnative versus native-English speaking teaching assistants (Levis, Levis, & Slater, 2012; Slater, Levis, & Levis, in press), and to offer practices in formative assessment that can help students develop academic discourse through decision-making (Leung & Mohan, 2004) and integrated language and content learning (Huang & Mohan, 2009; Huang & Morgan, 2003; Mohan & Huang, 2002) as well as offering opportunities to explore formative assessment through teacher–student exchanges (e.g., Mohan & Beckett, 2003). KS analysis has also played a role as an analytical framework for examining more standardized types of assessment, arguing, for example, that oral proficiency interviews can become problematic when there are shifts in the patterns of KSs (Mohan, 1998). KS analysis has also revealed similarities between a science teacher's language about science and an ESL teacher's language about science, arguing that the ESL teacher worked with KSs in much the same way as the science teacher did even though there were differences in the register and technicality of the texts. The similarity existed in the processes that each modeled regarding the types of thinking skills a scientist must exhibit in their science registers; the ESL teacher used simpler and much more commonsense language to model these than the science teacher did (Slater & Mohan, 2010).

What all the above research has suggested is that the use of an SFL social practice approach to analysis, and in particular a KS analysis, has the potential to reveal important patterns of teaching and learning that may otherwise be missed. The research addressed above has focused on the patterns of KSs within the process of building specific registers, much of these in science, yet the idea of examining social practices using the KS, following Mohan (1986), has the potential to examine similarities across registers as well as any differences, as Slater and Mohan (2010) suggested.

To help move research into the exploration of these similarities, Mohan (2011) described four different cases of social practices in education—teaching and learning about magnetism by primary school students, doing online discussion compared to face-to-face discussion in a graduate course, cooperative learning in ESL classes, and carrying out action research with non-English-speaking students—showing how an SFL approach to analysis can provide both the metalanguage and the tools to "examine the role of language as a means of learning in social practices" (p. 71). In other words, whereas using this social practice perspective has illuminated register development and use within specific educational domains, relatively little has sought to compare learning across social practices. Such research is needed in order to understand more fully the role of language in language across curricular areas (Barwell, 2005; Halliday, 2007; Mohan, 2011; Mohan & Slater, 2005; Street, 2005).

We now turn to two studies, both on the development of science registers in two different social practices, that were carried out to provide a deeper understanding of the role that theory/practice pairs of KSs play in the teaching and learning of science at two grade levels (Mohan & Slater, 2005; 2006). Our aim in reviewing these two articles in particular is to provide sufficient detail and examples of the types of KSs from these two science classes to allow us to make a comparison between KSs in science language and the language of a teaching unit on inventing territorial games that was developed and taught to a sixth grade PE class using a Teaching Games for Understanding (TGfU) approach (see Griffin & Butler, 2005).

4. Linguistic research on social practices in science

Mohan and Slater (2005), one of the cases described in Mohan (2011), showed how the learning of magnetism by first- and second-grade English language learners was established linguistically through the connection between *doing* experiments with magnets, which provided students with the hands-on action, and *talking about* the experiments, which provided opportunities for dialog between Mrs. Montgomery (a pseudonym), the teacher who understood the theory she was teaching, and her students, who were learning about magnetism. This study took place over approximately four weeks (ten 40-minute lessons) in three classes of 21-22 mixed first to third grade students (ages 6 to 8) who were mostly English language learners in an inner city elementary school in a large Western Canadian city. Mrs. Montgomery taught all three classes with one researcher (one of the authors of the study) assisting and collecting audio data. These audio data were transcribed and analyzed using Knowledge Structure theory. The authors showed how Mrs. Montgomery expertly built up a simple model of magnetism for the students which included creating with the students several taxonomies (classification) and constructing logical relations (sequences and cause/effect relations), a pattern that followed Halliday's views on the development of science (Halliday & Martin, 1993). Through the use of all six KSs in oral discourse, Mrs. Montgomery systematically guided her young students into new ways of thinking about magnets by using questions and tasks that helped them make connections between what they were doing with magnets and what the simple theory was that she wanted them to know. This research supported related work by Gibbons (1998), who focused on the shift through mode from face-to-face interaction with action, to reporting that action, to writing about what students had learned. Gibbons noted that as the students moved through this mode continuum, their language shifted from incorporating features characteristic of context-embedded discourse to those of much more context-independent text.

Mohan and Slater (2006) carried out a similar discourse analysis using the same social practice register approach with three classes of ninth-grade students (average age of 14) learning about the topic of matter. The three classes, which took place in a large diverse high school in Western Canada, were taught by Mr. Peterson (a pseudonym) with a researcher (one of the study's authors) collecting audio data and taking field notes as the classes proceeded over a ten-week period with each lesson lasting 40-60 minutes every other day. Each class had 29 or 30 students who were rated through testing as advanced speakers of English, although 25 to 50 percent spoke a language other than English at home. As with the primary school data, these were transcribed and analyzed using the Knowledge Structure theory approach. (For details on the larger study that encompassed both Mr. Peterson's and Mrs. Montgomery's lessons, see Slater, 2004). In this report, the authors presented examples from the classroom interactions, analyzed using a KS social practice framework. As with Mrs. Montgomery working with her primary school science unit, Mr. Peterson built up various relevant taxonomies (description and classification), worked with students to help them understand the logical relations among the concepts (sequences and principles), and explicitly addressed students' informed choices in problem-solving activities (choice and evaluation) related to the theory of matter that he was teaching. The article tracked through the language how the theory Mr. Peterson was teaching was systematically matched to the practice that the students were engaged in.

In the analysis sections of this paper, we will present examples of the knowledge structures taken from the two articles by Mohan and Slater so that they can be compared and contrasted to the data from a sixth-grade TGfU-based PE course to reveal the linguistic connections that surface between the physical nature of PE and the mental nature of science. Before we begin our comparison, we will describe our PE unit in more detail as well as the theory that informed its teaching.

5. The current study: The language of a TGfU unit on inventing territorial games

The TGfU approach was chosen for examination because it foregrounds decision-making and the "debate of ideas" (Richard & Wallian, 2005, p. 26), and thus promotes both the action discourse and reflection discourse of a social practice. Its learner-centered and game-centered approach to teaching PE is rooted in the notion of constructivist teaching and learning and provides numerous opportunities for the teacher to use tasks, questions, and discussions to develop students' tactical knowledge about the particular areas of content being taught. These teacher-directed opportunities for talk provide contexts for the natural use of academic language and the corresponding thinking skills described in the KF. Below we will show how within the TGfU approach, the teacher asked questions and assigned discussion tasks that helped guide students to focus on—and use—the language of the various knowledge structures within this TGfU unit. Through this, we aim to illustrate how the teaching and learning of PE connects with the teaching and learning of science.

The PE data presented here were collected at a diverse elementary school in a large Western Canadian city over approximately one month during three 40- to 60-minute class periods per week, from one sixth-grade class of 30 students aged about 11 years old and their teacher, whom we call Mr. Johnston. The students, who reflected the general demographics of the city, were considered advanced enough in English to participate in regular classes, although some spoke a different language at home. The unit, which focused on having students invent a game, had its first meeting in a large classroom, then continued from the second meeting in the school gymnasium, where students worked in five groups of six with the teacher calling them together at the beginning of each class and from time to time when he felt he needed them to focus on particular topics. The data were collected using audio- and video-recording equipment and were later transcribed for both the PE and the linguistic analyses. The PE researcher used the transcripts to explore the complexity of the game structurally, the interactions between students as they created games, the constraints they imposed on themselves, and the students' analysis of their game rules (Butler, 2013), while the linguistics researcher was interested in analyzing the language that Mr. Johnston and his students used to construct content and relationships.

Before we focus on the specific examples of KSs in the PE discourse, it is important to address the characteristic language of action and suggest that action alone is not constructing content knowledge in an explicit manner. In game situations, students are usually caught up in the action. Cummins (2013) distinguished between basic interpersonal communication skills (BICS), the language used in face-to-face conversational situations, and cognitive/ academic language proficiency (CALP), which is needed more in cognitively demanding, context-reduced, often problem-solving or critical thinking situations. Like BICS, the discourse around action tends to be commonsense and interpersonal (many commands and observations)—in fact, the action of some activities may not produce any discourse at all! The following is a typical example of the types of action discourse that characterized the game play of the sixth-grade students (S).

S: I… My stick

S: Three two one

S: Get the ball. Get the ball.

S: Go easy. *(Lots of hard playing, scrambling, little language)*

S: Oh my gosh we knocked it down. We knocked it down! *(More scuffling* *sounds, hard playing, little language.)*

S: STOP!

S: Stop!

This type of action discourse, also noted in Gibbons (1998) and Slater (2004) as being typical of the language of action in science, is grounded in the activity at hand and is more about social interaction and controlling action than it is about games (Gibbons, 1998). The TGfU approach advocates opportunities for students to go beyond the play and reflect on the action of the game and to make sense of it at some distance from immediate play and at a broader level of the game. This type of reflection is typically done through extended speech:

S: Now see the way Noel and Al are passing it? That's the way I want you and Ashley to be. Okay? Okay pass okay?... Thank you. Jesse pass to Ashley. Bart don't always stop it.

It is interesting that these reflections produced longer and more explicit utterances in much the same way as Gibbons (1998) reported in her examination of teaching and learning science. Whereas Gibbons's Stage 1 science texts showed a reduction of interpersonal elements in the discourse over time, this was not always the case in the breaks in action that occurred on the teacher's whistle in the PE classes. Some of these breaks were for students to talk about how their game invention was coming along and how their games could be improved, and thus the interpersonal aspect, as shown above primarily through the use of commands and vocatives (names), remained high as students instructed each other regarding potential improvements and changes. In other words, without teacher prompting using specific questions, these latter types of utterances in the

PE class, although distinctly different from the action of the game, did not always promote or reflect the use of all the KSs discussed in the science teaching articles; they instead remained much more closely related to the initial action-based category described in Gibbons (1998), despite the longer utterances. It appears as though in PE, the reflection language needed to be brought out systematically, using tasks and questions in ways similar to how the science teachers used KSs to build science knowledge.

In the following sections, we will examine the PE data from each of the three theory/practice pairs of knowledge structures of the KF, bringing attention to the similarities between the PE classes and the earlier described science data.

5.1 Description/Classification

As previously discussed, description deals to a large extent with describing, labeling, and locating things and people, and classification with grouping and defining. Table 1, adapted from Mohan and Slater (2005; 2006), offers discourse excerpts from the primary science and high school science classes that capture the teachers' focus on carrying out these descriptive and classifying tasks in the classroom.

Table 1: Examples of description and classification language from two science classes (adapted from Mohan and Slater, 2005; 2006)

MRS. MONTGOMERY'S CLASS (PRIMARY)	MR. PETERSON'S CLASS (HIGH SCHOOL)
DESCRIPTION/CLASSIFICATION T: Do we know what that word attract **means**? S: No. T: What does that word attract **mean**? H: I think um… if the thing **is made** out of metal and you can… the **there's** a force that	**DESCRIPTION/CLASSIFICATION** T: Say I had two pieces of metal, and I ask you do you think they**'re** the *same* metal or *different* metals? A lot of metallic <u>elements</u> **look** silvery. How would you tell if they**'re** the *same* metal or *different* metal? M: <u>Density</u>…

will pull it so it stays. T: Good. It stays there. Hannah said an energy force… will pull it. S: And you can stick it on the refrigerator and it will stay because it**'s** cold. T: You think these magnets can stick on our refrigerator because it **is** cold?… Well we're going to discover that. We're going to discover if it**'s** because it'**s** cold or if it'**s** something else. S: But we don't **have** a refrigerator. T: Not here we don't. But we've **got** the magnet wand and this **is** all our experiment. So we're going to put our wand next to each one of these things. T: Now *on your bar magnet* **there are** two letters. S: S N. T: An S… and an N. I wonder what they **stand for.** S: North	T: What's density **mean** anyway? *By definition*? Let me say this substance **is** more dense than that substance. M: How compact it **is**. T: Okay you've got the idea. What *kind of units* does density use to measure? Quantitative *properties*. So if you just ask what **is** the density of a substance and I were to tell you, what *kind of units* might I use? J: Grams. T: Grams would be a mass *unit*. You've got the right start. Grams per amount? Isn't it? Per volume or per area or what? What do you think? S: Volume. T: So grams per volume then. Your volume unit **comes in** cubic right? Cubic centimeters **is** one. Grams per cubic centimeter. How about if I asked you this. What**'s** the *difference* between lead and aluminum? I: Lead **is** heavier.

Note: **Bold** = specific KS processes; *italics* = language associated with specific KS; underlined = general rather than specific sense

Several tasks that the PE students were assigned were also directly related to these classification and description thinking skills. In the initial PE lessons, Mr. Johnston directed his students to think about what a game is, and to list the many games that they were familiar with. In assigning these two tasks, he created a natural context for students to use the language of classifying and defining. As mentioned earlier, the language of classification is particularly noticeable in the use of processes of **being** and **having**, which we have marked in **bold** face. We have identified lexis associated with the KS in *italics*. We have marked the general sense of games (which we have underscored), to show its difference from reference to a specific game, thus highlighting the general theory of games:

T: The first thing is I want you to do is with your felt and with your entire group is to look at your big white sheet and I want you to come up with together… *sort of a definition* for what **are** games. What does that **mean** when I say play games? What do you think that is right? You only have about two minutes to do this. Okay? What **are** games is the big question. Okay go ahead.

S: What **are** [games?

S: [What**’s** a game?

S: It**’s** like—

S: Games **are** having fun.

S: Fun. [F. U. N.

S: [Games **are** things you play to have fun.

S: Everybody **have** fun

And a few minutes later:

T: So the next thing I want you to do **is** come up with *a list* of games.… Okay? So just let me clarify. So *a list* of games. You might put… I don’t know Pin the Tail on the Donkey. **Is** that a game to you? I don’t know.

S: Yeah.

T: Baseball. **Is** that a game to you? S said that before and I said great. That**’s** *an example* so put that down. Okay? So a list **is** of as many games as you can think of. All right? Go ahead.

Notice how Mr. Johnston moves between games as a general category and specific examples of games that students might be familiar with, such as Pin the Tail on the

Donkey, or baseball. Through this, he pushed students to consider both what games are (theory), and to create a list of games they had some level of experience with (practice).

Once the students had created their lists, the teacher attempted to get them to group their games in a way that would make their classification explicit and justifiable. Interestingly, he chose science as a way of helping students understand classifications.

T: You **have** some incredible *lists* in front of you. Some of them in my head I didn't think they **were** games? But it's clear to me that you think they**'re** games and that's… that's the whole point of what we're doing right now. Okay? So make sure… make sure… that all the games that were said *are listed* because each individual game **is** something *different* right? And that**'s** good. What I want you to do now **is** a serious challenge and I'm actually concerned I'm going to have to break it down even smaller rather than just jump into it… but I think we can do it. Okay? So I want you to give it a shot when I tell you what it is. I'm going to ask you to look at the games that you created… or wrote down or you didn't create them yet… and try to put them into neat little *categories*. Like how would you… *classify*— does everyone know what *classify* **is**? From like science? *(Some background quiet chatter in response.)* Do you *classify* organisms as mammals reptiles amphibians? Like that? So… if you look at the sports that are in front of you… or the games or exercises or whatever you chose… how would you *classify* those games? So let's look up here. Can you give me a couple more foods? Just for *an example* I thought I would write food. Can you give me a few more that aren't here? Elly?

Such classification discourse was very noticeable particularly in the early lessons of this unit and provided the foundation for identifying and discussing characteristics of the type of games students would be inventing (territorial games). These initial tasks used students' existing understandings of classification and description to construct a new, TGfU taxonomy of games (see Butler & McCahan, 2005, pp. 42-44).

Once the students began the task of creating their games, they were required to draw their proposed playing area on their worksheets and to draw and label the equipment used in their games. The language in their groups was representative of the language of description as they worked on these tasks. As with our earlier excerpts, we have marked the processes typical of description in **bold** and have used *italics* for the language associated with this knowledge structure, such as prepositions of location and similes. Notice how the students are now talking more specifically about their game and its players rather than about all games in general. Also note that description and classification are not the only knowledge structures being constructed in this discourse; all social practices, including creating games, typically contain evidence of all six of Mohan's knowledge structures (Mohan, 1986). The task, however, has directed students to focus on this particular set of knowledge structures.

S: Okay. **There's** going to be a net *there*, and then **there's going to be** bean bags and a goalie *in front* trying to block the goal. We throw balls right? We're trying to shoot before anyone takes us. We shoot and get the bean bags.

S: Hold on. Hold on.

S: **There's** goalies right. You score the beanbags and you got to take a bean bag and take it *back to your team*.

S: The goalie**'s** *on the other side* trying to block your guys… *into their goal*. They're trying to score from with… *inside their net* but **there's** a person from the other side who's trying to block them.

S: Or we can just…

S: You can also take the ball…

S: **There's going to be** two kinds of balls *like those ones*.

S: They have to like they **have to have** their own balls right? (All are talking at the same time.)

S: So **there's going to be** a net *here* and a line *here* right?

The discourse showed how the teacher and his students worked cyclically and systematically with classification and description throughout the unit. Students learned the general classification of games, how their game fit into this classification, they drew and labeled their playing areas, and when showcasing their games later, the students used the language features of classification and description to help their classmates understand their games and how their invented game was characteristic of territorial games.

Notice the similarities of the PE unit and the two science units described earlier in Mohan and Slater (2005; 2006) and summarized in Table 1. In both science units, the teachers used classification and description early in the teaching cycle to identify the concepts that the lesson would involve. Mrs. Montgomery ensured that her primary students understood the concept of attract (e.g., "What does that word attract mean?") before she set them loose on testing a list of items (e.g., "this is all our experiment"). She came back regularly to classification and description as she built up the various taxonomies needed for her simple theory of magnetism (e.g., “Now on your bar magnet there are two letters”). Similarly, Mr. Peterson began his unit on matter by working with the students to create a taxonomy of properties that could be used to distinguish various elements, defining each property so that students understood it (e.g., “How would you tell if they’re the same metal or different metal?”), a task that elicited large samples of the language of classification and description.

5.2 Sequence/Principles

Within this PE unit, there were several opportunities for students to use the language of sequence. They listened to instructions from the teacher regarding what to do, they recounted what was done or seen, and they created instructions for how to play their games. In showcasing the games, the students were required to tell their classmates how their games should be played. As with the earlier analyses, this excerpt from one of the showcased games uses **bold** to identify the processes that build sequence and *italics* to mark other key sequence lexis.

S: You **start** at the back of the black line behind the goal.

S: *When* the game **starts** you run to get the red ball.

S: *When* you get the ball you try to get the red tape side and score the ball in the goal.

S: But don’t get tagged.

S: *Every time* you score the scorekeeper **will** give you one point.

S: *When* the other team comes on your side you can tag them *and* they have to go jail. You can get to your teammates *and* get them out of jail by getting them from the other team jail but only one person *at a time*.

Understanding PE games means more than knowing the sequence of the games, it entails understanding the rules and objectives of the games, both in general (to all games) and concerning specific games. The teacher thus involved students in a discussion of the importance of rules in games, and gave the students the task of having to create five rules for their own invented game and to discuss the roles of coaches and officials in general and in their invented games. Examples of students' written rules ranged from "get tagged, go to jail" and "*if* there's a bigger area, you have two rubber balls" (cause and effect) to "you can get to your teammates and get them out of jail *by* getting them from the other team jail but only one person at a time" and "we use the hockey stick *to* shoot the ball at the pins" (means/end). In whole-class discussions surrounding rules and sequences, one of the most frequent questions the teacher asked was "why?" to elicit the students' understanding of basic game theories as well as to understand the rules of the student-created games. In the following examples, as before, **bold** highlights the processes that are concerned with principles, and *italics* mark key resources of the knowledge structure of principles.

Eliciting basic theories of games:

T: … what's the point of having *rules*? *Why* would a game want to have *rules*?

S: **To keep** order and also **to keep** people from cheating.

T: That's a really good answer. **To keep** order to the game and maybe **to keep** them from cheating. Are people cheating *if* they break the *rules*? Is that kind of what you're saying?

S: Yes.

Eliciting reasons and rules for the students' games:

S: We use two balls *because* uh *because* of the bigger area. Before when we were in the corner of the gym we couldn't put two balls *because* they'd fly everywhere *because* one ball was really troubling. *So* then now that we have a bigger area we think we should have two balls.

T: *Why* though?

S: *Because* uh everybody gets a chance to play *cause if* one ball there's too many people. Everybody will whack uh the ball.

S: *If* one ball goes out of bounds everybody has to wait. But *if* there's two balls they can continue with the other ball.

T: It increases the flow. You **made** it more fair for everybody.

Notice how Mr. Johnston moves between theories or principles that are characteristic of all games (the first excerpt in this section), and the rules that students created for their specific games (as in the latter excerpt). Through his frequent use of why-questions, he connected students' individual games to the broader standards, or theories, of games in general.

This move between the students' specific practices or observations and the general theory being taught was also made clear in the science discourse data through the connections between sequence (what students saw or experienced) and principles (the theory being taught). As we can see from the excerpts taken from Mohan and Slater (2005; 2006) shown in Table 2, Mrs. Montgomery carefully guided her primary students through recounts of their experiments (e.g., "So what happened here?") to build for them the simple theory of magnetism that she was teaching. Mr. Peterson talked his way through demonstrations (e.g., “Here’s a rubber stopper in water.”) as one way to help students understand the concepts of terms such as *density*, alternating between the language of sequence (what we experience) and the language of principles (what this experience means in the broader field of scientific theory). In both science classes and in this PE class, the teachers used sequence to connect to principles in similar practice/theory relations.

Table 2: Examples of sequence and principles in science classes (from Mohan & Slater, 2005; 2006)

MRS. MONTGOMERY’S CLASS (PRIMARY)	**MR. PETERSON’S CLASS (HIGH SCHOOL)**
SEQUENCE/PRINCIPLES T: So… what *happened* here? S: It *repelled.* T: They’re *repelling*. Right. They were *repelling* and I’m going to *turn* this one over. What do we call this? North or south? S: North. T: North. It doesn’t matter. I’m *turning* it over. What… S: *Attract.* T: So if it’s *attracting* what is underneath here? North or south? S: South. T: South. Right. The bottom is probably north and this part is *Because*? S: *Because* north and south. T: *Because* north and south and what do north and south always *do*? *What is the rule*? S: *Attracts.* T: That’s right. North and south always *attract.* What *repels*? S: North and north or south and south. T: So the ring magnet has a north and south? S: Yes. T: How do we know? J: Because we tried it out. T: And? What did we discover?	**SEQUENCE/PRINCIPLES** T: What *determines if* something *floats*? S1: Density**.** T: In water. Density. Exactly. So *if* something *sinks* in water would you guess it’s more or less dense? Uh ice *floats* just below well… *floats* low in the water. Correct? T: Here’s— here’s a rubber stopper in water. (Drops it in.) S: Whoa! T: Rubber’s more dense than water. Here’s a cork in water. (Takes out the rubber stopper and drops the cork in.) S1: Less… T: It *floats* quite high. Right? S: Yes. I: It’s so cool. T: Okay. Ice would *float* lower. Right? Cork’s is around point two five. About a quarter as dense as water. Now *why* things *sink* or *float* in water is *dependent* on density.

S: <u>Magnets</u> *attract*. T: Let Jack finish. J: Because if you *turn* it around it won't *attract* and if you *turn* it around it'll *attract*. T: So it has a north and south? Yes it does. And is it all on the same side of the magnet? J: No. T: No. One side of the magnet will be? J: North. T: And the other side of the magnet will be? S: South. T: Right. And when we have two souths *coming* together they are going to? S: Um *repel*. T: *Repel*. If we have norths *coming* together they are going to? S: *Repel*. T: If we have a north and a south *coming* together they're going to? S: *Attract*. T: *Attract*. Just like the other **magnets**.	

Note: **Bold** = specific KS processes; *italics* = language associated with specific KS; <u>underlined</u> = general rather than specific sense

5.3 Choice/Evaluation

Choice is decision-making. One could in fact argue that all participation in sports involves decision-making, frequently at high speeds, as athletes act and react in disciplined and reasoned ways, based on their understandings of what the game values (or does not value). This entire TGfU unit was about making choices in order to invent new territorial games. The worksheet guided students to think deeply about their choices so that they could identify areas of their games that could be altered to make the game more skill-focused, and to evaluate how any new suggestion could improve the game.

A common feature of choice and evaluation discourse is the process of *thinking*, a word that occurred often throughout the discussions and which we have marked in **bold** face in the examples below. As Martin and White (2005) explained, the use of modal verbs and appraisal language is also a key aspect of choice and evaluation, and so we have identified modal verbs by using UPPER CASE, and marked appraisal language, which implies opinion, in *italics*. Notice in the following example how the student has identified a problem and must decide how to fix it, which is a central focus of the TGfU approach.

S: I **wonder** how come *so* many players here. I COULDN'T see the ball where I was going. There was *so* many it's *crazy* like there's no position and everybody's like *fooling around*.

T: Yea how COULD you change that?

S: I don't **know**. Like…

T: I **think** you just said the answer. One way of changing that MIGHT be what?

S: Positions.

T: I **think** that MIGHT be right. Positions. Then people would have a place to be and a place to play. So then you MIGHT get more… Max?

S: I **agree** with Lisa cause if you were playing… field and everybody was on the team get kind of *crowded* and you MIGHT get the ball twice. But I **think** it WOULD work *better* if you played it with more people. If you played it in more sections.

As students talked with each other through the creation of their games, they made choices (which equipment to use, what their playing field would look like, what the rules would be, how many players would be on each team, etc.), and they evaluated their options sometimes with and sometimes without the help of the teacher, but always with specific tasks or questions to guide them. Most of the PE unit, in fact, was a problem to solve (how to create a game) with the students in groups interacting to make choices. To do this successfully, Mr. Johnston spent part of a lesson introducing and defining the democratic process, with students offering examples of how to make choices democratically:

T: I asked somebody if they COULD tell me what the democratic process meant.

S: Everybody votes and gets a voice.

T: Yea. *Good. Well put.* So in voting and making sure that everybody gets a voice. That's kind of the process how your group SHOULD work.

Mr. Johnston elaborated:

T: What happens if there's a fight? What if… I'm using Group 4. Say that Lance and Deena totally **disagree**. Uh Lance **thinks** we SHOULD use a ball and Deena says no way. It's got to be a Frisbee. SHOULD they go to fists?

T: What do you **think** the *best* way to kind of resolve that problem is? Yeah?

S: Like discuss it?

T: Discuss. What do you do to discuss it?

S: Like say why don't we just like vote for whose is like *better* and then they find out which one and then make a game…

T: So Deena WOULD say "this is why I **think** it's a Frisbee"? OK. *Good.* And what if it's half half? There's six people and three people say three people say ball and three people say Frisbee. You're *in trouble* aren't you?

Yes.

S: Use both.

T: That was *really good*. Did everyone hear that? You COULD make the game so that both the implements—the ball and the Frisbee—are used. That's *really good*. And then nobody's *mad*. Well we **hope**.

Notice again how Mr. Johnston used examples from the specific contexts to connect to the overall theory of the democratic process, matching specific actions that are commonsense to the students with the more general theory and principles that he was attempting to teach. This matching also occurred in both science contexts, as the examples in Table 3 below show. Mrs. Montgomery frequently presented opportunities to the students to make choices by asking them to **think** about why things happened (e.g., "why do you **think** it isn't attracted?") and to justify their choices based on their current understandings, which involved other KSs such as description and classification (e.g., "maybe it**'s** not metal"), and sequence and principles (e.g., "*because*…"). Similarly, Mr. Peterson also presented problem-solving opportunities ("Now your job is to separate them into four piles. How WOULD you do that?"), and encouraged his students to use their understandings to make reasoned choices (e.g., "**think** physical properties." Thus, in all three contexts, the teachers were responsible for guiding the students towards a more reasoned choice and justification, based on the common values, principles, and standards of their respective fields.

Table 3: Examples of choice and evaluation in school science (from Mohan & Slater, 2005; 2006)

MRS. MONTGOMERY'S CLASS (PRIMARY)	MR. PETERSON'S CLASS (HIGH SCHOOL)
CHOICE/EVALUATION A: Hey it doesn't. T: It doesn't. Why doesn't the key… what do you **think** Janie? J: It doesn't. That key's *small*. T: It's because it's *too small*? Why do you **think** Abby? Why do you **think** it doesn't… why do you **think** it isn't attracted? A: Mm… it doesn't attract. I don't **know**. Maybe it's not metal. T: Maybe it's not metal. A: It doesn't stick. T: Is that not metal? A: No… maybe? I **think**? Yeah. I just **think** that not metal. It looks like metal.	**CHOICE/EVALUATION** T: Now your job is to separate them into four piles. How WOULD you do that? There's the **thinking** science nine students' way and then there's the *extremely tedious* well you COULD get a microscope or a magnifying glass and a pair of tweezers and you pick out all the things—it'd take you forever! Especially if there's a big pile of them. So. It's important that you do it in the *right* order actually I **think**. You gotta **think** which one do I do first. Hint? Physical properties. That's how you do it. **Think** physical properties. What's the physical property this stuff has that the others don't. That's how you do it. Stan**?** S1: Use a magnet to separate the iron? T: …Right. There's one. Iron's attracted. None of the others are. What's next? What WOULD you do next? Yeah? S2: Dissolve the salt in water. T: Add water. The salt will dissolve. The sand and the gold won't…. Okay what's next. You've got sand and gold. I: And there's some water too. J: Add more water. K: Pan for gold. T: **Think** of a physical property that separates the two. Like you can go crystal shape? No not going to help. Solubility? No neither of them dissolve. No viscosity? No that's for liquid. Magnetism? Neither are magnetic. Color? Well that's *good* if you want to do the tweezers method okay? **…**How does panning work? You got this kind of like big dinner plate right? M: Add water to it. And shake it around and the gold is more dense so it'll sink to the bottom and the sand will— T: But the sand WOULD sink too WOULDN'T it? M: No. It WOULD sink but if you keep spinning it WOULDN'T.

Note: **Bold** = specific KS processes; *italics* = language associated with specific KS;

UPPER CASE = modals; <u>underlined</u> = general rather than specific sense

6. Discussion

All content areas across the curriculum presuppose the existence of appropriate registers, as registers “map the relationship between the context and the lexicogrammar” (Coffin & Donohue, 2012, p. 66). Moreover, all good teachers in the content areas are aware of the knowledge (theory) they are attempting to teach and the actions (practice) that they will use to engage their students to help them develop understandings of this knowledge (Black, 2001; Mohan & Slater, 2005). The two science articles that formed the crux of our non-PE data established that both science classes illustrated this systematic matching of knowledge and action, theory and practice, and we could see this by examining the discourse as it constructed patterns of KSs. Our analysis of the PE discourse showed very similar patterns, suggesting that, as Halliday (2007) noted, language varies not in a random way but according to what we are doing. In other words, although the registers of science and PE differ in characteristic ways that allow us to identify them as representative of their disciplines, they are similar in their use of KSs for teaching and for constructing knowledge within their areas. Pre-service teachers who are learning to plan effective lessons in any curricular area need to know this. Moreover, these findings open up interesting avenues for teaching (in particular, formative assessment), collaboration, and policy-making surrounding the development of academic literacy.

All three teachers worked initially to build up taxonomies that were relevant to the content they were teaching: magnetism, properties of matter, or types of athletic sports games. In doing so, all three teachers carefully and systematically attempted to shift students’ understandings from what they brought into the classroom to what was valued in the particular field at their particular levels of instruction. For example, Mrs. Montgomery moved her students from magnets “stick” and “not stick” to understandings of “attract,” “not attract,” and “repel.” Mr. Peterson’s students learned to talk in terms of “density” and other physical properties. Similarly, Mr. Johnston questioned students’ classifications of “pin the tail on the donkey,” to ensure they understood how to group games within the taxonomy outlined by the field of sports. All these classroom excerpts showed the discourse of classification and description—not exclusively, though, as students were frequently making choices regarding their understandings of their content areas, but as the lessons progressed, these choices became informed by the theories they were learning about the topic, which included the relevant taxonomies and their characteristics.

All three teachers also worked to build understandings of logical reasoning. Mrs. Montgomery had her students recount what they did in their experiments, then worked with them through questions to build understandings of the *why* behind what they had witnessed. Mr. Peterson frequently did running commentaries of his short demonstrations to show students so that he could connect this action with the theory he was teaching, moving from the concrete and observable to the more abstract understandings of the theory he was teaching about matter. As with the science classes, Mr. Johnston in PE questioned the students about *what* they were doing and got them thinking about *why* they were doing it, connecting their actions with the theories of games, fair play, and movement that he was aiming to develop.

All three teachers had one or more problem-solving activities in which students were required to participate in reasoned decision-making. Mrs. Montgomery’s students were guided through the simple problem of trying to establish whether ring magnets had two poles, and Mr. Peterson's students needed to use their newly evolving knowledge about physical properties to separate a mixture. The problem that the PE students were to use their informed decision-making skills for was larger—they needed to invent a game—but this involved the same kinds of academic thinking skills in similar patterns. All groups of students still needed to be able to use classification and description to build taxonomies, to use sequences and principles to build logical sequences, and to apply these understandings to reasoned decision-making to show their understanding.

Such decision-making plays a key role in learning through language—in order to make an informed choice, one needs to understand the theory that informs the choice. This thus plays a major role in classroom teaching, and particularly in formative assessment. Mrs. Montgomery established what the students had learned about magnetism through the problem solving that she introduced regarding the ring magnets, and Mr. Peterson was able to ensure that his students understood at least the physical properties that were involved in the separation of those specific elements from the mixture they were part of. Mr. Johnston had plenty of opportunities for formative assessment as he watched students in groups plan and execute their games. His observations informed his discussion questions, which in turn impacted how the students constructed their games as they made alternative choices based on their evolving understanding of the theory of games. This back-and-forth movement between the practice of the games and the theory that Mr. Johnston introduced or reinforced during reflections on the game helped students understand their choices and their consequences better, just as the matching of theory and practice in science helped the students there learn their respective content. Such matching of theory and practice is an important part of sports, as quick decisions in the action of a game need to be made based on the player's understanding of the rules, objectives, and classifications of the game.

In teaching, Leung and Mohan (2004) suggested that using group discussion in which students are required to make reasoned choices enhances learning "in any subject area at any level," as it offers a window into how the students are applying their understandings and that students who engage in these problem-solving activities frequently are "likely to be better prepared for written academic discussion" (p. 356). Although written tasks were not explored in the PE unit or in the two science units that the PE unit was compared to, it would seem likely that students who had gone through the process of learning described in these studies would have a head start on writing their understandings over students who had not been systematically introduced to this knowledge. But much this would depend on the teachers' participation in this. As Martin (2013, p. 33) noted, teachers need not only to unpack unfamiliar "power words" and "power grammar" into commonsense terms as they frequently do in oral discourse, they need to ensure that students understand and can repackage these to consolidate the knowledge that is being constructed. Without such consolidation, students will not easily be able to use these aspects of language in their reading and writing.

In all three teaching and learning contexts, the role of action was critical in the cycle of knowledge construction as well as for formative assessment. In all three classes, the teachers were able to see what the students were *doing* either through their actions (most noticeably in Mrs. Montgomery's class and in the PE class), or through specific reflection about what they've *done* before (as was part of the language of all three classes). This action aspect of a social practice offers great potential for exploring the development of language and thinking (Mohan, 1986) in much the same way as we have outlined here. Further, Wells (1999) argued for a theory of learning that brings *doing* to a higher level of consideration than it has been. He stated that learning:

> …involves learning to do as well as learning to mean—to expand one's action potential as well as one's potential for meaning through language. Discourse, both spoken and written, plays an essential, mediating, role in this process, together with other semiotic tools. But the object of all this learning is not just the development of the learner's meaning potential, conceived as the construction of discipline-based knowledge, but the development of the resources of action, speech, and thinking that enable the learner to participate effectively and creatively in further practical, social, and intellectual activity. (p. 48)

The role of action in learning is most obvious in PE, where what students are able (or are not able) to do has typically offered the foundation for assessment, either formative or summative. Language has not typically been considered to play a large role in this process in PE, where the focus has frequently been on the physical (Butler, 2013). It is critical, however, to ensure that students are aware of the connections between doing and knowing, so that they are moving beyond a *hands-on* involvement to a minds-on *activity,* thereby lending accountability to the teaching and learning tasks. Mohan (1986) cautioned about the dangers of using "doing" as an alternative to "knowing" instead stating that doing "is a way of knowing… [it] is not an alternative to talk; it is a context for talk" (p. 46). As we saw in the PE unit here (and which is a characteristic of TGfU), action *and* talk were both important contributors to knowledge building, just as they were in the science classes. More importantly, the TGfU-based PE unit provided a context for explicitly connecting the action and the talk and the discourse to help the teacher assess what the students were learning and how they were talking about that learning.

This important connection between knowing and doing and the language associated with each can provide policy-makers with a solid argument for considering PE as an academic subject in all schools worldwide. Depending on how PE is implemented in the schools, as we have shown, it can move beyond its perceived focus on movement and physicality to highlight the development of thinking skills through language in much the same way as science does. Moreover, using a KS perspective to understand the similarities and differences between various disciplines in the school may provide a foundation that can better facilitate cooperation between content specialists in different subjects (e.g., science and ESL in Slater & Mohan, 2010).

In all three contexts, the teachers worked to have their students show progress toward their learning objectives, using questions and tasks that would help construct the relevant taxonomies and logical sequences of their particular content areas and to create opportunities for students to apply this theory to practice and to make informed, reasoned decisions. These discursive moves are all necessary elements of academic literacy, and we are suggesting that good teachers make expert use of these across all curricular areas. These KSs and the moves among them need to be highlighted so that teachers and policy-makers can see how students are learning to use them across the disciplines.

7. Conclusion

PE teachers engage students in the social practice of learning content related to sports. Other teachers engage their students in other discipline-specific social practices. In each of these content areas, there is a distinct register that constructs the knowledge, making the texts that are spoken or written recognizable as belonging to that content area; good teachers in any discipline expertly teach these registers so that their students learn. PE, when it is taught well, is not simply "just a break from the "serious" work of education and… valued only for the benefits it brings to "rest" cognitive faculties in the interest of learners being able to work better in lessons that follow" (Whitehead, 2013, p. 26). Good teaching in any content area will involve thinking skills—knowledge structures—that students need to use across the curriculum. In focusing on the role of language as a medium of teaching and learning PE, we used KS analysis to examine the discourse of sixth-grade students and their teacher, aiming to show how the PE teacher's tasks and questions guided students to use specific language to construct specific knowledge structures that reflected the thinking skills common and critical for constructing the content in their discipline. The idea that these knowledge structures and their linguistic characteristics occur across content areas is not new; Mohan (1986) offered a detailed discussion of their occurrence, advocating that teachers of English language learners bring this metaknowledge to the students through task and resource choices. What is new about the current project is the research about how these knowledge structures pattern in the oral discourse that is part of knowledge construction across two subject areas that have been perceived as being distinctly different, such as PE and science, and the implications for this research on broader teaching practice.

There are many people who, when asked to compare science and PE as school subjects, would admit that although both may use language at some point in the lesson, they are very different in how that language is used, with the science class using talk to teach and learn content in a much more explicit and discourse-laden way than what is noticed in a typical PE class. Yet when an analysis is done on the underlying thinking skills of a PE class that involves language, such as through a TGfU approach, we have seen that the thinking skills and corresponding language have many core and important similarities, an argument that supports the presence of PE as part of the academic curriculum. Street (2005) suggested that the identification of hidden features of classroom discourse can benefit teachers and policy makers in that this can help defend or promote the use of oral language in developing literacy across curricular areas (such as PE and science). Moreover, understanding how KSs pattern across the curriculum can lead to better collaboration between teachers who are striving to meet the goals of content literacy set out in the US Common Core Standards, and to those involved in the always challenging field of teaching academic language and literacy to English language learners in any geographic location using any disciplinary content.

If we consider, as does Mohan (2011), that the goal of education is to socialize learners into the various social practices of the community and that language is the primary means of this socialization, we can see that a linguistic analysis of any social practice can reveal connections about the use of language in teaching and learning (which is a social practice), and we can also imagine how the use of language in teaching one field, such as science or physical education, connects to the teaching of any other social practice. By considering the PE unit as a holistic unit of meaning with a theory aspect (the theory of territorial games) and a practice aspect (inventing a territorial game), and by using the KSs to analyze examples of the discourse and then comparing these to similar samples of teaching and learning in science teaching, we can see how all three educational contexts have similar underlying linguistic structures that appear in similar patterns, cyclically moving from description/classification to sequence/principles to choice/evaluation. More work needs to be carried out on this to establish whether this pattern holds true for other curricular areas, but the current findings show much promise.

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